REMARKS

In view of the above amendments and following remarks, reconsideration and further examination are requested.

In the Office Action of March 14, 2008, the Examiner rejected claims 7 and 9-10 as being indefinite in view of the language of the preamble. Accordingly, claim 7 has been amended to recite a seal system as well as a positive recitation of the shaft. As such, the Examiner's rejection should now clearly be overcome.

Claims 7, 13 and 14 were rejected by the Examiner as being unpatentable over Hosokawa et al., US Publication No. 2001/0030398, in view of Bertin, US Patent No. 4167981. The Examiner apparently meant to reject claims 9-11, as claims 13 and 14 have been cancelled, and claims 9-11 are discussed in the rejection. The Examiner is taking the position that the claimed ratios are obvious. However, the references do not properly disclose or suggest the claimed invention, as will be carefully explained below.

(I) The Present Invention

In a conventional lip-type seal, since the lip-type seal is placed in a high-pressure environment of at least 5MPa in regular use when CO_2 or the like is used as a refrigerant of the compressor, the lip part is increasingly worn out, and its durability is lowered, in spite of the fact that the lip part is supported by a support ring. The present inventors have diligently performed research and discovered that the "scooped wear-out phenomenon" as shown in Fig. 7A occurs in a region of the lip part where the thickness of the lip part is thin and "toppling wear-out phenomenon" as shown in Fig. 7B occurs in a region of the lip part where the lip part is thick. Based on a technical idea that it is more

desirable from the viewpoint of durability to expand the contact width of the lip part in a high-pressure environment, the present inventors have found that parameters α =(T0/T1) and β =(D1-D0)/D1 are important in order to prevent "scooped wear-out phenomenon" and "toppling wear-out phenomenon" and are effective in order to prevent the above-mentioned phenomenona when satisfying respective predetermined ranges of values simultaneously, and further have found the critical condition of the upper and lower limits concerning the parameters α =(TO/T1) and β =(D1-D0)/D1 by the results of an endurance test.

As understood by Fig. 8 which shows results of an endurance test varying the parameters α =(T0/T1) and β =(D1-D0)/D1, when the parameter α =(T0/T1) is not less than 0.65 and when the parameter α =(T0/T1) is not more than 0.35, wear-out in the sliding area between the shaft and the lip part becomes large. In particular, when the parameter α =(T0/T1) exceeds 0.65 as shown in Fig.8, the "toppling *wear-out phenomenon"* is liable to become large, whereas when the parameter α =(T0/T1) is below 0.35, a decrease in rigidity of the end part of the lip part becomes too great, whereby large wear-out by the *"scooped wear-out phenomenon* "occurs.

According to the results of an endurance test varying the parameter α =(T0/T1) while varying the parameter β =(D1-D0)/D1, the present inventors have confirmed that when the parameter α =(T0/T1) is in a range of 0.3 to 0.7, the volume of wear-out is sufficiently permissible, and that the limit condition causing the *"toppling wear-out phenomenon"* is nearly 0.7, and the limit condition causing the *"scooped wear-out phenomenon"* is nearly 0.3.

Also, as understood by Fig.8 which shows the results of an endurance test with varying the parameters α =(T0/T1) and β =(D1-D0)/D1, even though the parameter α =(T0/T1) falls within 0.3 to 0.7, when the parameter β =(D1-D0)/D1 is not more than 0.04 and when the

parameter β =(D1-D0)/D1 is not less than 0.12, wear-out in the sliding area between the shaft and the lip part becomes large. In particular, when the parameter β =(D1-D0)/D1 is below 0.04, initial deformation is small so that the *"toppling wear-out phenomenon"* easily occurs, whereas when the parameter β =(D1-D0)/D1 exceeds 0.12, an influence of the *"scooped wear-out phenomenon"* is liable to increase.

According to the results of an endurance test varying the parameter β =(D1-D0)/D1 while varying the parameter α =(T0/T1), the present inventors have confirmed that when the parameter β =(D1-D0)/D1 is in a range of 0.04 to 0.12, anomalous deformation is prevented, and the seal is preferably deformed to enlarge the contact width of the seal surface whereby the volume of wear-out is sufficiently permissible, and that the limit condition causing the "toppling *wear-out phenomenon"* is nearly 0.03, and the limit condition causing the *"scooped wear-out phenomenon"* is nearly 0.15.

As mentioned above, in order to prevent the "scooped wear-out phenomenon" and "toppling wear-out phenomenon", the present inventors have performed an endurance test with varying not only one of the parameters α =(T0/T1) and β =(D1-D0)/D1 but also both parameters α =(T0/T1) and β =(D1-D0)/D1, and as a result, have found the critical conditions of both parameters α =(T0/T1) and β =(D1-D0)/D1.

That is to say, based on a technical idea that it is more desirable from the viewpoint of durability to expand the contact width of a lip part in high pressure environment, although it is conventional common sense to maintain a line-contact state in order to secure sealability and under based on the above-mentioned results of an endurance test, the present inventors have achieved the present invention that includes the following features (i), (ii), and (iii) simultaneously:

(i) the lip part (23) is formed so as to extend linearly under non-pressure condition,

(ii) the lip part (23) is tapered in cross section from an area at which non-contact with the annular supporting part of a support ring begins toward the end of the lip part, and

(iii) the lip part (23) is formed such that a value α =(TO/T1) falls within 0.3 to 0.7 with T1 being a thickness of the lip part at the area at which non-contact with the annular supporting part begins, and TO being a thickness of the end of the lip part, and such that a value β = (D1-D0)/D1 falls within 0.03 to 0.15, with DO being an inner diameter of the end of the lip part, and D1 being an outer diameter of the shaft.

And, according to the present invention, by the combination of the above-mentioned features (i), (ii), an unexpected result and advantageous effect is obtained as follows:

1) the "scooped wear-out phenomenon" and "toppling wear-out phenomenon" can be prevented.

2) the surface pressure is dispersed to lower a maximum surface pressure, whereby wear-out of the lip part is reduced, and sealability and durability are improved.

As mentioned above, the limitation regarding the parameters α =(TO/T1) and β =(D1-D0)/D1 is not a matter of mechanical expedience.

(II) Hosokawa et al.

The Hosokawa et al. reference discloses a lip-type seal comprising an elastic seal ring(5) that includes an annular fitted part (5a) and a lip part (13), and a support ring (12) that includes an annular joint part and an annular supporting part (12a). The lip part (13) is pictured in Fig. 1 so as to be tapered in cross section from an area at which non-contact with the annular supporting part begins toward an end thereof. Hosokawa et al. discloses only an

interference fitting by Fig. 1. Further, as noted in paragraph 43 of Hosokawa, the tip end 14 of the lip end 13b makes line contact with the face of the shaft in use.

The Hosokawa et al. reference does not disclose a critical condition or a range of value of the interference fitting, any explanation about the tapered configuration of the lip part, or the above-mentioned "scooped wear-out phenomenon" and "toppling wear-out phenomenon."

The Hosokawa et al. invention is based on the technical idea that a lip part is formed so as to prevent contact with the shaft in large area (i.e. face-contact) by restriction of an excessive deformation of the lip part caused by high pressure.

(III) With regard to Bertin

The Bertin reference discloses a lip-type seal comprising an elastic seal ring (i.e. a flexible membrane 4) that has a cupola as a lip part. The cupola has a continuously decreasing thickness from its base (3) of the thickness e_2 to the contact ridge forming a sealing lip (1) of the thickness el. The cupola is curve-formed so as to convex outwardly (toward a pressure side) and is formed so as to satisfy the ratio e_2/e_1 being 1 to 2.

However, the Bertin reference does not disclose a support ring for supporting the lip part, a lip part formed so as to extend linearly when high pressure is not applied, or the above-mentioned "scooped wear-out phenomenon" and "toppling wear-out phenomenon." Also, the Bertin reference does not disclose a support ring having an annular supporting part that extends to a middle region of the lip part. Therefore, thickness e_2 of the Bertin reference does not correspond to the thickness T1 (of the present invention as shown in Fig. 10B) of an area at which non-contact with the annular supporting part begins.

Claim 7 requires that the support ring have an annular supporting extending to a middle region of the lip part and supporting the lip part. The claim further requires that T1 is a thickness of the lip part at the area at which non-contact with the annular supporting part begins. The ratio

of T0/T1 is thus based on the thicknesses at the area of the lip part over which there is noncontact. There is no recognition in Bertin, or Hosokawa, of the importance of this ratio.

Also, the Bertin reference invention is based on a technical idea that a lip part (cupola) is curve-formed so as to convex outwardly and therefore to prevent the deformation toward a shaft by itself without a support ring. In other words, the Bertin reference invention is based on a technical idea that a lip part (cupola) is curve-formed so as to prevent the contact with the shaft in large area (i.e. face-contact) by restriction of the excessive deformation of the lip part caused by high pressure.

Further, the Bertin reference discloses a lip-type seal including the features that the seal is made of rubber, reinforced at its base by a frame, with a substantially continuous inner profile (as described on column 1 lines 6-10), that the lip part is formed as a cupola formed from a plastic material and has a continuously decreasing thickness from its base to the contact ridge with the shaft (as described on column 1 lines 23-29), that the adoption of a meniscus shape counterbalances the effect of two factors (i.e. impregnation with oil and temperature increase) and so maintains in these silicone seals, the expansion at a low value, thus avoiding a considerable pressure drop at the contact ridge (as described on column 1 lines 43-48), and that the bordering surfaces of the cupola or meniscus forming the membrane, inside and outside, in the form of spherical or toric surfaces, whose radii of curvature R1 and R2, respectively for the inside and the outside, will be little different, the centers of curvature being moreover at some distance from each other (as described on column 1 lines 53-59).

That is to say, the Bertin reference invention is based on an adoption of a lip part formed as a cupola or meniscus configuration but not formed as a straight configuration.

(IV) ***Comparison Between the Present Invention and the Cited Inventions***

The cited inventions of Hosokawa et al. and the Bertin are based on a technical idea that a lip part is formed so as to prevent the contact with the shaft in large area (i.e. face-contact) by restriction of the excessive deformation of the lip part caused by high pressure, whereas the present invention is based on a technical idea that it is more desirable from the viewpoint of durability to expand the contact width of a lip part in high pressure environment.

Namely, there is an apparent difference of the technical ideas between the present invention and the cited invention of the Hosokawa et al. and between the present invention and the cited invention of the Bertin.

The "scooped wear-out phenomenon" and "toppling wear-out phenomenon," which have become a motivation for the preset invention, do not disclosed or suggested at all by the Hosokawa et al. or the Bertin.

The Hosokawa et al. reference and the Bertin reference do not disclose the parameters α =(TO/T1) and β =(D1-D0)/D1 at all. The Examiner states that Bertin discloses the T0/T1 parameter on the order of 1 to 2. However, it does not have an annular supporting part, and thus does not have a point where non-contact with the annular supporting part begins, and thus does not have anything to compare with the parameter T1. The stated reason of a reduction in pressure drop at the contact ridge is a reason related to the structure of Bertin, and not the present invention. While the discovery of an optimum range of a result effective variable may only involve routine skill in the art, this is dependent upon those of skill in the art knowing that the variable is result effective. This is not the case here, because there is no recognition of the ratio of T0/T1, as there is no recognition of the importance of the point where non-contact with the annular supporting part begins, i.e. T1. Further, Applicant has shown unexpected advantages as explained above.

Further, the Examiner's reasoning regarding the ration of (D1-D0)/D1 is based on ensuring the lip end portion sufficiently contacts the rotation shaft to prevent fluid leaks. However, this is unsupported by the art. There is no recognition in the art of the importance of this ratio or anything that would leave one of ordinary skill in the art to this range.

With consideration of the above-mentioned difference, it is difficult for a person skilled in the art to apply the curved lip part of the Bertin to the tapered straight lip part of the Hosokawa et al., and therefore, it is difficult for a person skilled in the art to accomplish the present invention that simultaneously includes the above-mentioned features (i), (ii), and (iii) on the basis of a technical idea as a positive adoption of face-contact. Also, the present invention has the unexpected results and advantageous effects 1) and 2) as mentioned above.

Accordingly, it is respectfully submitted that there is no proper disclosure or suggestion of the present invention as set forth in claim 7 and its dependent claims. Indication of such is respectfully submitted.

In view of the above amendments and remarks, it is respectfully submitted that the present application is in condition for allowance and an early Notice of Allowance is earnestly solicited.

If after reviewing this Amendment, the Examiner believes that any issues remain which must be resolved before the application can be passed to issue, the Examiner is invited to contact the Applicants' undersigned representative by telephone to resolve such issues.

Respectfully submitted,

Koichiro OIYAMA et al.

/Nils E. Pedersen/

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Nils E. Pedersen
Registration No.
Attorney for Applicants

NEP/krg
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
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